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WORKSHOP INSTRUCTIONS

STARTING MOTORS
WITH INERTIA-ENGAGED DRIVES

MODELS
M45G, M418G AND M35G

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STARTING MOTORS

WITH INERTIA-ENGAGED DRIVES

MODELS M45G, M418G AND M35G

1. GENERAL

The electric starting motor is a four-pole machine having an extended shaft to carry the engine engagement gear, or starter drive as it is more usually named.

Three starting motor sizes are in general use having yokes of $4\frac{1}{2}$", $4\frac{1}{8}$" or $3\frac{1}{2}$" diameter.

The starting motor is of similar construction to the generator except that heavier copper wire is used in the construction of armature and field windings.

Models M45G and M418G are four-brush machines and have series-parallel field connections.

Model M35G is a four-brush machine and has either series or series-parallel field connections. The plain series arrangement is usually employed for the 12-volt machines and the series-parallel for the 6-volt. Earlier model M35G starting motors were fitted with two brushes spaced at 90° on the commutator.

All standard models are designed to operate with an earth return system. There are, however, special models designed for use with insulated return systems. In these models, the brushes which would normally be earthed are connected to an insulated terminal on the end bracket.

The construction, operation and servicing of the various designs of starter drive are described in SECTION B-3.

2. ROUTINE MAINTENANCE

About every 12,000 miles take the cover band off the starting motor and carry out the following procedure:

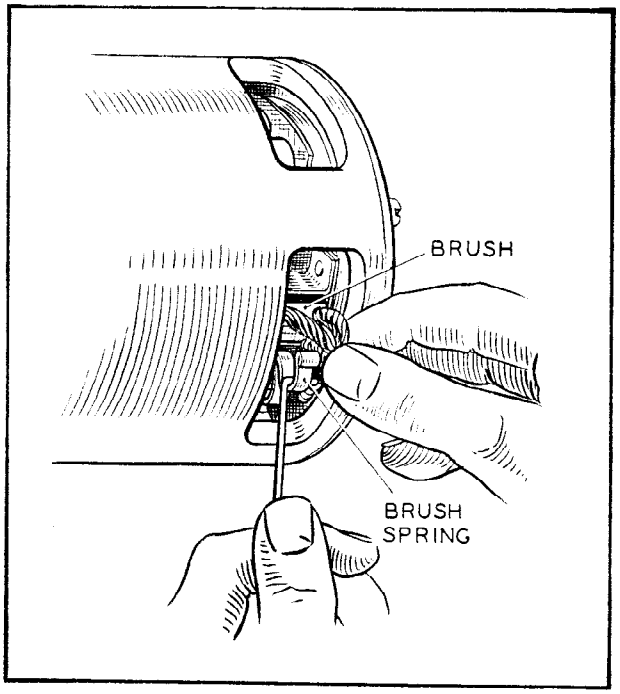

Fig. 2
Checking brushgear

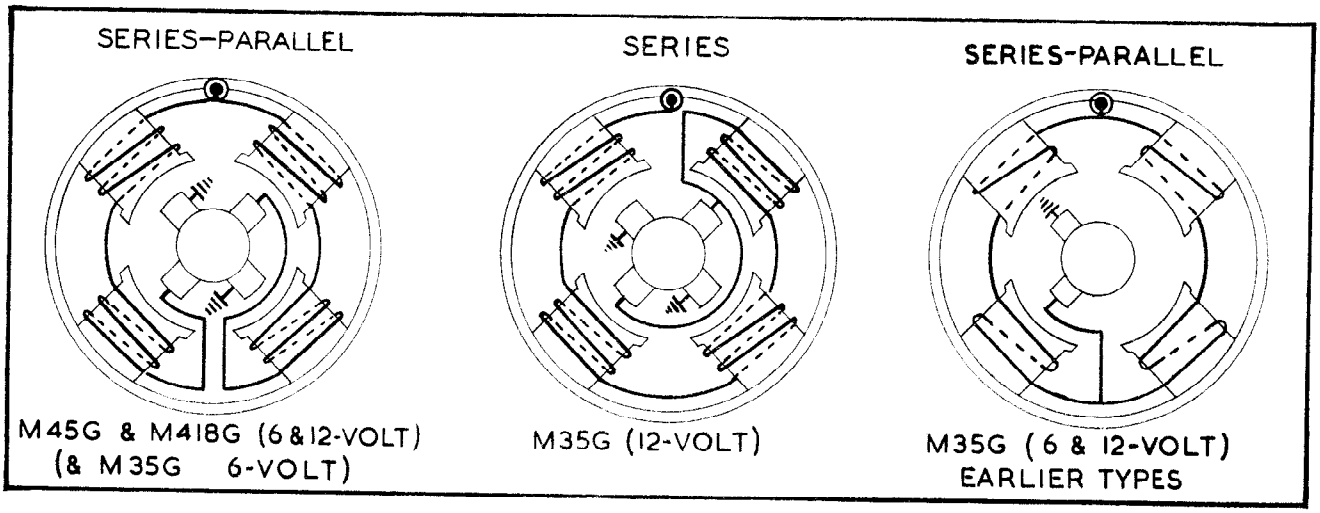

Fig. 1
Internal connections of starting motors

(a) Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If movement is sluggish, remove the brush from its holder and clean its sides with a fluffless petrol-moistened cloth. Replace the brush in its original position. Brushes which are worn must be renewed see para. 4(d) (i).

(b) Check the tension of the brush springs using a spring scale, see Fig. 3. The correct tension is 30—40 oz. for all models except model M35G (four brush) which is 15—25 oz. New springs must be fitted if the tension is low, see para. 4(d) (i).

(c) The commutator must be clean and have a polished appearance. If necessary, clean it by pressing a fine dry cloth against it while the starter is turned by applying a spanner to the squared extension of the shaft. Access to the squared shaft is gained by removing the thimble-shaped metal cover. If the commutator is very dirty, moisten the cloth with petrol.

(d) Keep all electrical connections clean and tight. Any which may have become dirty must be cleaned and the contacting surfaces lightly smeared with petroleum jelly.

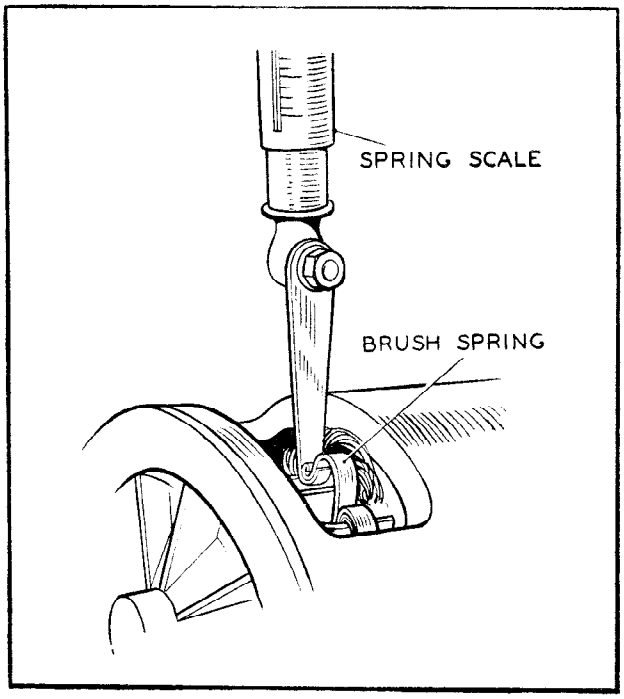

Fig. 3
Testing brush spring tension

3. PERFORMANCE DATA

Model	Nominal voltage	Lock torque (lb.-ft.)	Lock current (amp.)	Lock voltage	Torque at 1000 r.p.m. (lb.-ft.)	Current at 1000 r.p.m. (amp.)	Voltage at 1000 r.p.m.	Light running speed (r.p.m.)
M45G	12	22	430—450	7.8—7.4	8.3	200—220	10.2—9.8	5,800—6,800
	6	14	500—520	3.2—2.8	4.2	190—210	4.8—4.4	4,100—4,600
M418G	12	17	440—460	7.4—7.0	8.0	250—270	9.4—9.0	7,400—8,500
	6	10	490—510	3.0—2.6	4.0	290—310	4.2—3.8	5,500—6,200
M35G 12-volt (series field)		9.3	370—390	7.7—7.3	4.9	230—250	9.3—8.9	8,500—10,000
M35G 12-volt (series—parallel field)		10	420—440	7.8—7.4	5.4	250—270	9.2—8.8	9,500—11,000
M35G 6-volt (series—parallel field)		6	390—410	3.4—3.0	2.9	240—260	4.4—4.0	8,500—9,500

Light running current: 45 amp. (12-volt motors) or 70 amp. (6-volt motors).

4. SERVICING

(a) TESTING IN POSITION

If the motor does not operate or fails to crank the engine when the starting button is used, switch on the lamps and again use the starting button.

(i) The lamps dim and the motor does not crank the engine. Before examining the starter, check by hand-cranking that the engine is not abnormally stiff.

Sluggish action of the starting motor may be due to a discharged battery. Check by disconnecting the existing cables and re-connecting the motor to a battery known to be fully charged.

If the starting motor now gives normal cranking of the engine, the vehicle battery must be examined as described in SECTION G-2.

If the motor does not operate satisfactorily, it must be removed from the engine for examination, see para. 4(b).

(ii) The lamps do not dim and the motor does not crank the engine.

Check by means of a voltmeter or battery-voltage test lamp that the circuit up to the supply terminal on the motor is in order.

If no voltage is indicated, check the circuit from battery to motor via the starter switch. Ensure that all connections are clean and tight.

If the switch is found to be faulty, proceed as described in SECTION E-2.

A voltage at the supply terminal indicates that the motor has an internal fault and must be removed from the engine for examination, see para. 4(b).

If the motor operates but does not crank the engine, the drive mechanism is probably faulty. Proceed as described in SECTION B-3.

(b) BENCH-TESTING

(i) Removing the starting motor from the engine:

Disconnect the earth terminal on the battery to avoid any danger of short circuits. Remove the heavy cable from the starting motor.

If a starter switch of the solenoid type is mounted on the end bracket, disconnect the control cable. If a switch of the manually-operated type is mounted on the end bracket, remove the switch lever from the switch. This lever is held in position by the spring pressure of the switch plunger and the lever can be pulled out without disconnecting the wire control.

To replace the lever, insert at an angle to get behind the spring, then bring upright and push down until the slots in the lever register with the end cap.

Remove the mounting bolts and withdraw the starting motor from the engine.

(ii) Measuring the light running current:

Secure the starting motor in a vice. Connect the motor in series with a starter switch, an ammeter capable of carrying 600 amperes and an appropriate voltage supply. Use cables of a similar size to those in the vehicle motor circuit. A fixing lug on the drive end bracket is a suitable earthing point on the starting motor. Connect a voltmeter between the motor terminal and the yoke.

Operate the switch and note the speed of armature rotation, using a tachometer, and the readings given by the ammeter and voltmeter.

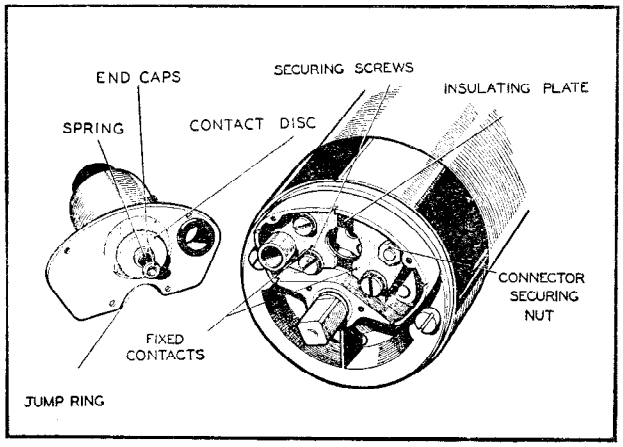

Fig. 4
Starting switch on end bracket

While the motor is running at speed examine the brushgear and check if there is any undue sparking at the commutator or excessive brush movement.

NOTE: With a few vehicles, on which the drive end bearing is incorporated with the engine, it is necessary to fit a slave driving end bracket to the starting motor in order to carry out this light running test.

(iii) Measuring lock torque and lock current:

With the motor firmly clamped in the vice, attach an arm to the driving pinion, see Fig. 5. Connect the free end of this arm to a spring scale. Operate the switch and note the current consumption, voltage, and the reading on the spring scale.

The measure of torque can be calculated by multiplying the reading on the spring scale in pounds by the length of the arm in feet.

If a constant-voltage bus-bar supply is used when carrying out the lock torque test, a higher lock voltage may be shown on the voltmeter than the appropriate value given in para. 3. In this event, a variable resistor of suitable current-carrying capacity should be connected in the battery circuit and adjusted until the lock voltage is the same as that given in para. 3. Take readings of current and torque at this value.

(iv) Fault diagnosis.

An indication of the nature of the fault or faults may be deduced from the results of the no-load and lock torque tests.

SYMPTOM	PROBABLE FAULT
Speed, torque and current consumption correct.	Assume motor to be in normal operatnig condition.
Speed, torque and current consumption low.	High resistance in brushgear, e.g., faulty connections, dirty or burned commutator causing bad brush contact.
Speed and torque low, current consumption high.	Tight or worn bearings, bent shaft, insufficient end play, armature fouling a pole shoe, or cracked spigot on drive end bracket.
	Short-circuited armature, earthed armature or short-circuited field coils.
Speed and current consumption high, torque low.	Short-circuited field coils.
Armature does not rotate, no current consumption.	Open-circuited armature or field coils. If the commutator is badly burned there may be poor contact between brushes and commutator.
Armature does not rotate, high current consumption.	Earthed field winding or switch (if mounted on end bracket). Armature physically prevented from rotating.
Excessive brush movement causing arcing at commutator.	Low brush spring tension, worn or out-of-round commutator. 'Thrown' or high segment on commutator.
Excessive arcing at the commutator.	Defective armature windings.

If any fault is indicated, the motor must be dismantled, see Para. 4(c), and a further check made.

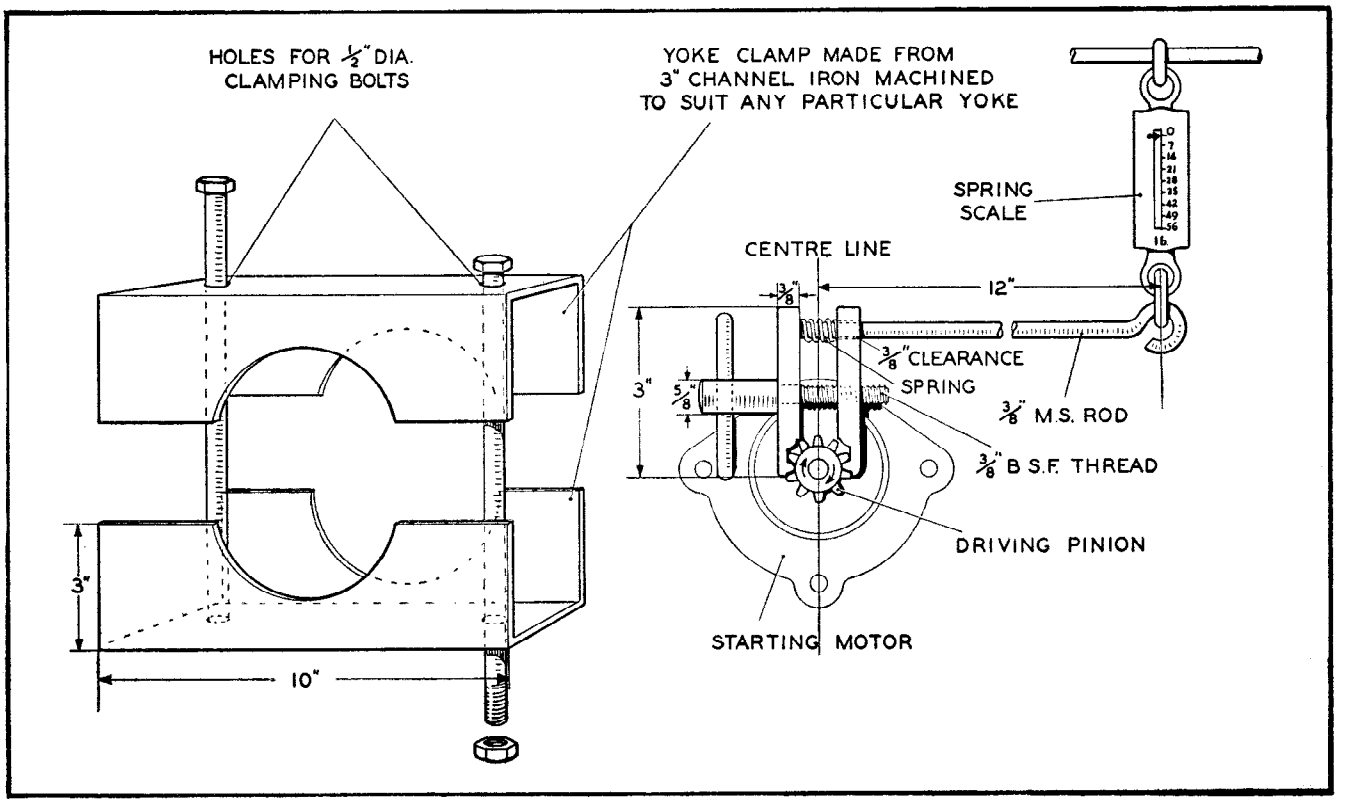

Fig. 5
Method of measuring stall torque and stall current

(c) DISMANTLING

Remove the cover band, hold back the brush springs and lift the brushes from their holders.

If the switch is of the pattern secured to the commutator end bracket remove the switch as described in SECTION E-2 and slacken the terminal nut securing the field coil connection.

With starting motors having the field coil terminal post protruding from the commutator end bracket, unscrew the terminal nuts from the terminal post.

Unscrew the two through bolts from the commutator end bracket, and remove the commutator end bracket from the yoke.

Remove the driving end bracket complete with armature and drive from the starting motor yoke.

Certain starting motors with outboard drive incorporate an intermediate bracket between yoke and drive end bracket.

(d) BENCH INSPECTION

After the motor has been dismantled, individual items must be examined as follows:

(i) Brushgear.

Where necessary, the brushes and brush-holders must be cleaned using a clean fluffless petrol-moistened cloth.

To prevent damage to the commutator, brushes must be replaced when worn to $\frac{5}{16}$" in length. The flexible connectors can be removed by unsoldering, and the connectors of the new brushes secured in place by re-soldering. The brushes are pre-formed so that bedding to the commutator is unnecessary.

Check the brush springs as in para. 2(b). To fit a new spring, prise open the spring anchor slot in the brush spring support post and lift the old spring away. Place the new spring in the slot in the same position as occupied by the old spring. Reclose the slot. Check the tension of the new spring and ensure that it makes contact with the centre of the brush.

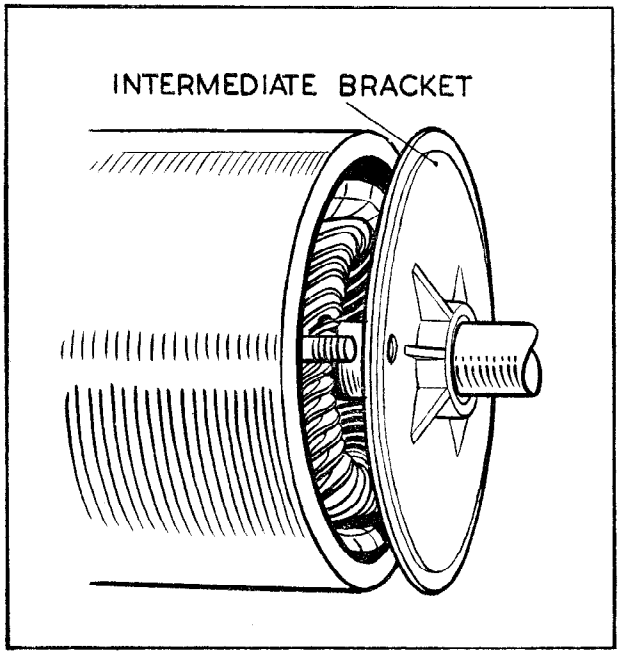

Fig. 7
Starting motor with intermediate bracket

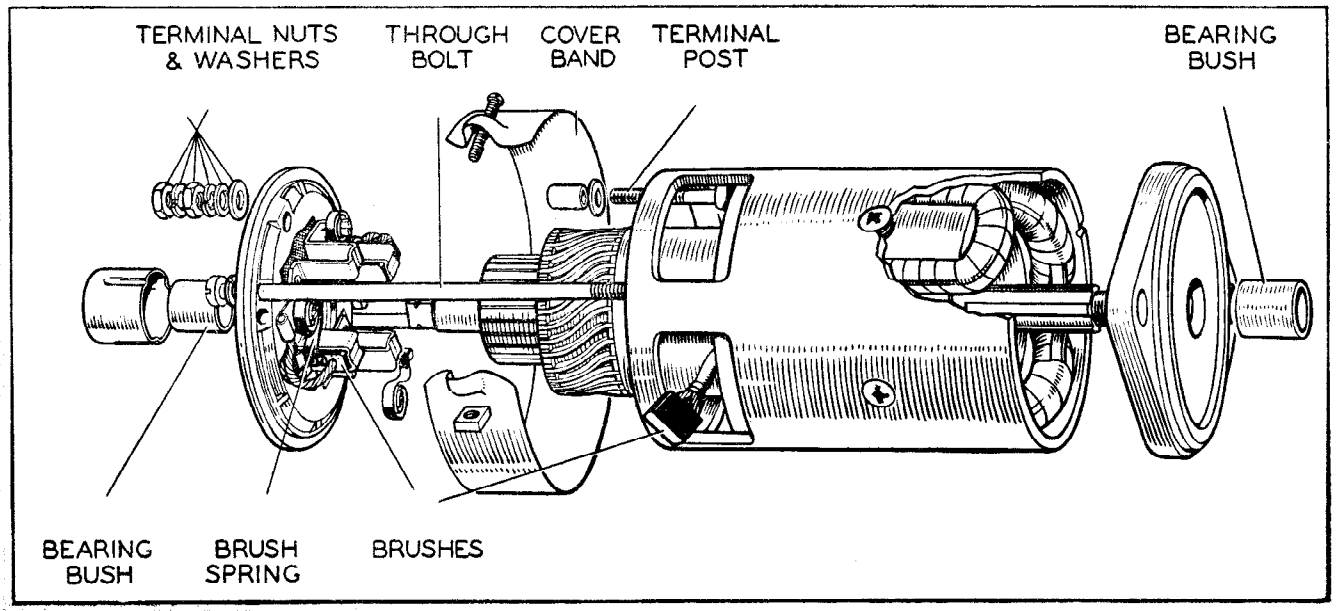

Fig. 6
Dismantled view of starting motor model M35G

(ii) Commutator.

The commutator must be clean and have a polished appearance. If it is dirty it must be cleaned using a clean fluffless petrol-moistened cloth or, if necessary, by polishing it with a strip of very fine emery cloth.

To remedy a badly worn commutator, dismantle the starter drive as described in SECTION B-3 and remove the armature from the end bracket. Mount the armature in a lathe, rotate at a high speed and take a light cut with a very sharp tool.

Do not remove any more metal than is necessary. Finally, polish with very fine glass paper. The INSULATORS between the commutator segments MUST NOT BE UNDERCUT.

(iii) Armature.

Check for lifted commutator segments and loose turns in the armature winding. These may be due to the starting motor having remained engaged while the engine is running, thus causing the armature to be rotated at excessive speed.

A damaged armature must always be replaced—no attempt should be made to machine the armature core or to true a distorted armature shaft. An indication of a bent shaft or a loose pole shoe may be given by scored armature laminations.

To check armature insulation, use an ohm meter or a 110-volt a.c. test lamp. A high reading should be shown on the meter when connected between the armature shaft and the commutator segments. If a test lamp is used, it must not light when connected as above. Faulty insulation will be indicated by a low ohmic reading or by lighting of the test lamp.

If a short circuit is suspected check the armature on a 'growler'. The motor overheating may cause blobs of solder to short circuit the commutator segments.

If an armature fault cannot be located and remedied, a replacement armature must be fitted.

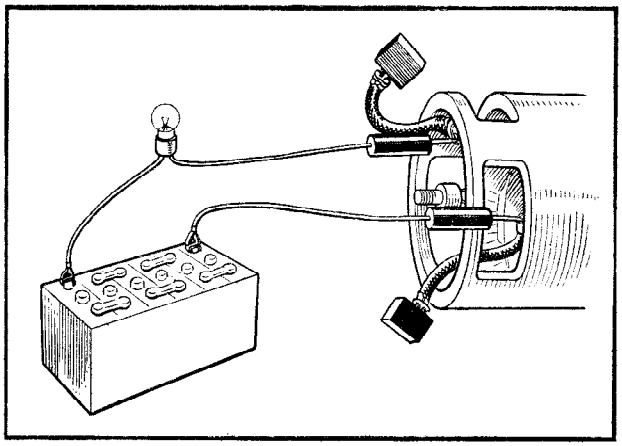

Fig. 8
Testing the field coils of models M45G, M418G and M35G (6-volt) for continuity

(iv) Field coils.

Continuity test:

Connect a battery and suitable bulb in series with two pointed probes.

If the lamp fails to light in the following test an open circuit in the field coils is indicated and the defective coils must be replaced.

With models M45G, M418G and M35G (6-volt), place the probes on the brush tappings. The bulb should light. With model M35G (12-volt), place one probe at the terminal post and the other at the brush tapping. The bulb should light.

With earlier model M35G starting motors disconnect the two field connections at the terminal post and place the probes on these connections. The bulb should light. Remake the terminal post connections.

Lighting of the lamp does not necessarily indicate that the field coils are in order. It is possible that a field coil may be earthed to a pole shoe or to the yoke.

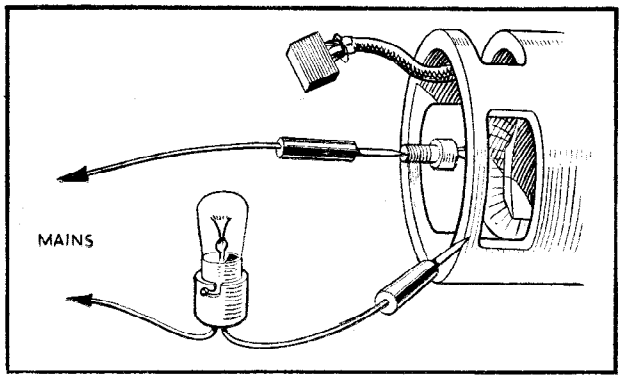

Fig. 9
Testing the field coil insulation in earlier model M35G starting motors

Insulation test:

Connect an ohm meter or a 110-volt a.c. test lamp between the terminal post and a clean part of the yoke. Lighting of the test lamp or a low ohmic reading indicates that the field coils are earthed to the yoke and must be replaced.

Replacing the field coils:

Unscrew the four pole-shoe retaining screws using a wheel-operated screwdriver.

Remove the insulation piece which is fitted to prevent the inter-coil connectors from contacting with the yoke. Mark the yoke and pole shoes in order that they may be re-fitted in their original positions.

Draw the pole shoes and coils out of the yoke and lift off the coils.

Fit the new field coils over the pole shoes and place them in position inside the yoke. Ensure that the taping of the field coils is not trapped between the pole shoes and the yoke.

Locate the pole shoes and field coils by lightly tightening the fixing screws.

Replace the insultation piece between the field coil connections and the yoke.

Finally, tighten the screws by means of the wheel-operated screwdriver.

(v) Bearings.

Bearings which are worn to such an extent that they will allow excessive side play of the armature shaft must be replaced. To replace the bearing bushes proceed as follows:

Press the bearing bush out of the end bracket.

Press the new bearing bush into the end bracket using a shouldered, highly polished mandrel of the same diameter as the shaft which is to fit in the bearing.

Porous bronze bushes must not be opened out after fitting, or the porosity of the bush may be impaired.

NOTE: Before fitting a new porous bronze bearing bush it should be completely immersed for 24 hours in clean thin engine oil.

(e) REASSEMBLY

This is, in the main, a reversal of the procedure given in para. 4(c) for dismantling.

Commutator end bracket replacement.

If the starting motor is designed for clockwise rotation, indicated by the arrow on the yoke, press out the through bolt indentations marked 'C' on the replacement bracket. With anti-clockwise rotating machines press out the indentations marked 'A'.

Press the locating dowel into the appropriate hole marked 'C' or 'A'.

Insert the through bolts into the holes made in the bracket and tighten the bracket to the yoke.

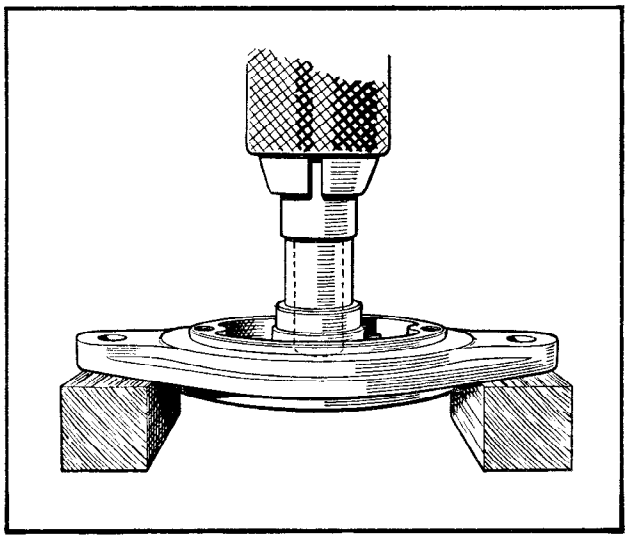

Fig. 10
Method of fitting bearing bushes